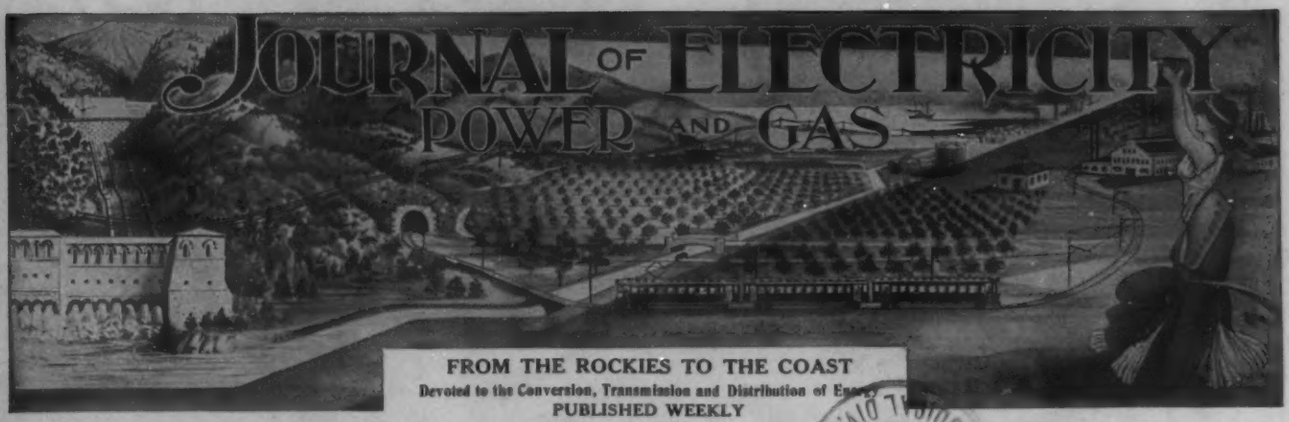
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FROM THE ROCKIES TO THE COAST
Devoted to the Conversion, Transmission and Distribution of Energy
PUBLISHED WEEKLY

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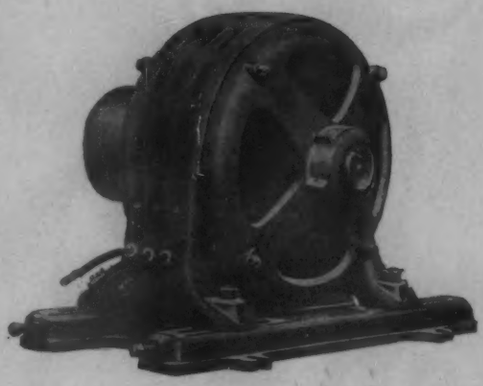

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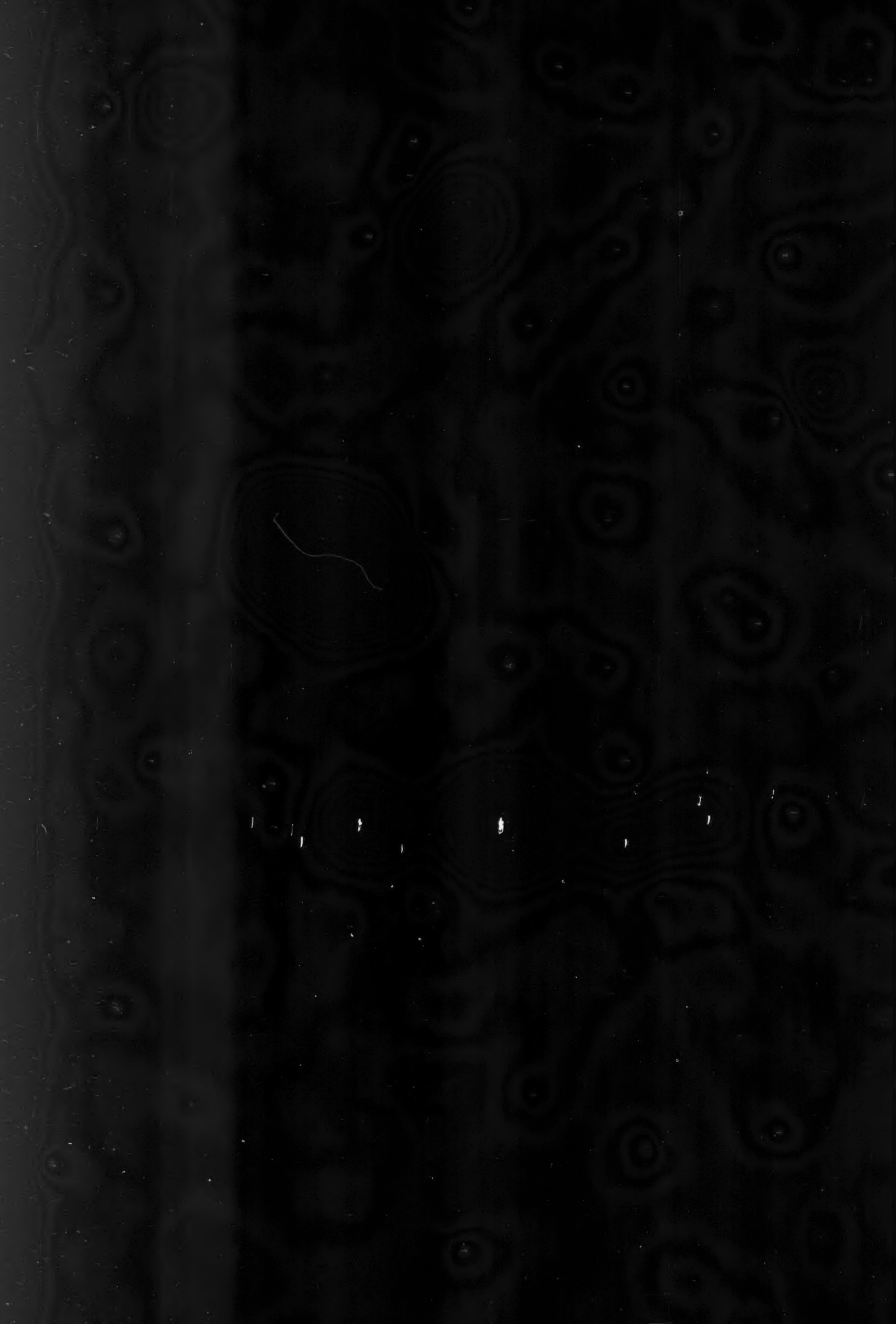


THE

Journal of Electricity, Power and Gas

Devoted to the Conversion, Transmission and Distribution of Energy.

VOLUME XXI. SAN FRANCISCO, CAL., SEPTEMBER 19, 1908 No. 12

PACIFIC COAST GAS ASSOCIATION

SIXTEENTH ANNUAL CONVENTION

The Pacific Coast Gas Association met in its Sixteenth Annual Convention at Santa Cruz, Tuesday, Wednesday and Thursday of the past week, with about seventy-five members in attendance. A number of instructive papers were read and several important suggestions made with regard to gas engineer's degrees.

Meeting Place at Santa Cruz, California.

As shown in the following congratulatory telegram Mr. George S. Colquhoun of San Francisco was elected President.

George S. Colquhoun,

St. Francis Hospital, San Francisco:—

The Pacific Coast Gas Association, convened in Sixteenth Annual Convention, congratulates itself on your election unanimously to the position of its President and sincerely prays for your immediate restoration to health, and promises for you in 1909 the most successful of all meetings under your administration.

JOHN A. BRITTON, Secretary.

Other officers elected were: W. F. Boardman of San Francisco, Vice-President; John A. Britton, Secretary and Henry A. Bostwick, Assistant Secretary. The Directors for the ensuing year are: Wm. Baurhyte, of Los Angeles, Cal.; E. L. Hall, Portland, Oregon; Frank A. Leach, Oakland, Cal. and C. F. Stamps, Los Angeles, Cal.

The business of the convention was closed by an enjoyable banquet at the Casino.

PRESIDENT'S ADDRESS.

By C. O. G. Miller.

As president of the Pacific Coast Gas Association, I welcome you to the sixteenth annual meeting. I feel those of us now here, who were present fifteen years ago last July, when this association was formed in the directors' room of the old San Francisco Gaslight Company, on First Street, must be well pleased with its great growth. This growth has been continuous, and I think we can all speak of our association as I sometimes do of our State, when I say I arrived in California in 1865, and ever since the State has been growing in wealth and population.

While our association has been prosperous without interruption, there is hardly a gas and electric company represented here that has not had a number of serious difficulties to contend with during the past fifteen years, and I shall in this address briefly touch on some of the dark sides of the gas and electric business. I say briefly touch, as most of our members write papers showiug concentrated thought on some important detail of our business, while I shall attempt to give a short account of several matters upon which volumes could be written.

Theoretically, men engaged in the gas business should give their principal thought to the manufacture and distribution of gas, and I suppose the larger number of people engaged in the business do so; nevertheless much thought has always had to be given to the protection of the investment, and I shall in this article confine myself to some of the dark sides of gas and electric investments.

C. O. G. Miller
President Pacific Coast Gas Association 1907 - 1908

Many years after pirates were driven from the seas, there were pirates in the gas business, and we still have them, although they are less in number and not so formidable. The tactics of the pirate are usually to build gas works to supply the heart of a city which is already being furnished by some prosperous company. This work is always accompanied by the assurance of the pirate that it is being done for the benefit of the community. At one time there was hardly a large gas company in the United States which had not been so attacked, but then there was usually in each city a center of consumption wherein with perhaps ten per cent of the mileage of pipe twenty to twenty-five per cent of the total gas made was sold. That is seldom the case now, still occasionally the pirate appears—often, however, to be captured and executed. In present days he is usually a promoter or man out of a job, and most companies view him with indifference. After pirating became no longer fashionable, and, what is more important, not so profitable, the principal dark side to the lighting companies appeared to be municipal ownership.

Twenty-five years ago there was a very strong tendency in the United States towards municipal ownership in all directions. Like the sixteen-to-one craze, it had its day, working hardship on many an honest gas investor, but always a greater hardship to the citizens of the community where it was practiced, and now, after having been tried in many places and almost invariably found unsatisfactory, the agitation on the subject has so much lessened that I think the larger gas companies of this country no longer view municipal ownership with alarm.

In this State the present manner of fixing rates is a dark side of the business. The Constitution of the State of California gives great power in the regulation of gas, electric, and water rates to the local municipalities. In the abstract this does not seem improper; few, if any, of the larger light and power companies question the wisdom of the State regulating rates; in fact, if a fair rate is fixed and protection is given the companies, they should welcome regulation. Up to the present time apparently not much attention has been paid to the subject by either the municipalities or the companies, and I am under the impression that, with the exception of the rates in effect in the largest cities, practically all of the gas and electric rates now in force in this State have been made voluntarily.

For the benefit of those members who have not actively participated at a rate-making meeting, I will give a brief account of one. In accordance with a written or advertised demand from the municipality, the company usually furnishes by January 31st of each year a statement of the receipts and disbursements of the previous calendar year, and a statement of the cost and value of the investment. Usually one session of the governing body is devoted to asking questions concerning the statement. Sometimes an expert is engaged by the city for the purpose of investigating the statement furnished by the company. If the city and the company are at no variance regarding the rate, this inquiry suffices; but when there is a difference, practice has usually made it necessary for the governing body to determine the rate after a very superficial and hurried investigation. It is extremely difficult for a layman to grasp the situation in the short time devoted to it, especially when he feels that his action in the matter may be misunderstood. When the time for the regulation of rates arises, a councilman or supervisor elected on a platform that calls for a reduction in the gas and electric rates is hardly in a proper frame of mind to listen to evidence and impartially vote thereon. No matter what the evidence is, if he does not vote for a reduction, a large number of citizens and all of the daily papers will accuse him of being biased in favor of the corporation. No reflection upon any city council or board of supervisors is intended. I assume every member of every municipal governing body is actuated by the highest motives, but that does not qualify such a man in the short time allotted to determine a fair rate for gas and electricity.

Other States have recognized the fact that the local governing body is not the best one to have jurisdiction over the rates, and presumably California will some day take action in the matter. The State of Massachusetts fully twenty years

ago provided a board of commissioners with large powers over the rates, and in recent years the State of New York has turned over the power of fixing rates to a State commission, and I think that the California members of our association should take up the matter of an amendment to our State Constitution so that a change may be made. Mentioning these facts alone will accomplish nothing; some one connected with the larger companies of the State should take hold of the matter and diligently attend to it until what is needed is accomplished. A resident of San Diego or Siskiyou County is very likely to impartially fix the rates for San Francisco or Sacramento, while the resident of San Francisco will probably make fair rates for Siskiyou and San Diego. It will take several years to have our State Constitution amended, meantime the companies will have to get along the best way they can. My close associates and myself have always been believers in low rates and have preached for years the doctrine that low rates and courteous treatment to consumers will do away with one-half the troubles of the gas man.

I might say a few words about taxation, a formidable question to those companies paying over $100,000 a year in taxes, especially as quasi-public corporations are usually assessed on a much higher basis than private individuals, but a solution of that matter is now before the people of this State in the form of a proposed amendment to the constitution. All members of this association and their friends should vote for the adoption of the amendment which takes the taxation of quasi-public corporations out of the hands of local assessors. Every change in the method of taxation and rate making that lessens the possible friction between quasi-public corporations and the community they serve makes the investment more secure, and should be welcomed by the corporations.

Now for a few of the pleasant features of our business. The stability of our business is a pleasant feature. Based upon the experience of the larger companies in California in 1893, 1896, and 1907, it is safe to say that the majority of consumers use approximately the same volume of gas and electricity in poor years as in good ones. With this regularity or stability in the business there goes of necessity a corresponding regularly in the profits, a very pleasant feature. With few exceptions, the gas man knows in January within ten per cent what his December business will be, and usually has time to provide for it.

Another pleasant feature of our business is the annual meeting of our association, where we are always so well looked out for by our secretary, who, I understand, has again amply provided for our entertainment.

Electric meters in New York State must hereafter conform to the standard established by the Public Service Commission. Chief Hazen, who is in charge of the laboratory of the commission, says that all electric meters in this State must be regulated according to the Albany standard. All the electric companies are required to provide themselves with standard testing instruments and to make reports each month to the use to which they are putting the instruments. The resolution adopted some time ago by the commission, following numerous complaints from consumers that their meters were not registering properly. The law requires that the commission shall inspect every meter, but this was found to be impracticable on account of the immense expense and large force of inspectors which would be required.

THE STORY OF CARBON IN OIL-GAS MANUFACTURE.

By F. C. Millard.

Owing to the extent of the manufacture and consumption of oil gas on the Pacific Slope, particularly in California, the question of carbon, or lampblack, is one of importance.

We shall use the term "carbon" in speaking of what a great many people call "lampblack." Carbon, strictly speaking, is a coked oil of a very fine nature, and is the principal by-product in the manufacture of oil gas. The quality of carbon is governed to a large extent by the grade of oil used and the candlepower maintained in the gas; the amount of dead oils in the carbon varying from only 6 or 7 per cent up to 20 per cent where the candlepower of the gas is maintained at a higher level.

The carbon is removed from the gas while it passes through the washbox, after leaving the generator. This washbox, containing a metal diaphragm, and partially filled with water, separates the carbon from the gas as it passes through the water and around and against the diaphragm. From the washbox the carbon is carried with the overflow water to a small seal pot, where it is observed by the operator and retained long enough for him to determine the candlepower of the gas being made. A competent operator is enabled to determine the quality of the gas within one-half a candle by this observation at the seal pot. He is also enabled to closely estimate the amount of water being used in the washbox. From the seal pot the carbon is carried through a drain pipe, in large plants, to a collection pot, where the carbon from all the generating sets is deposited before finally being carried to the settling pits.

A carbon settling pit consists of a large excavation with an ordinary flume drain with irrigating-ditch gates, as an inlet for water and carbon, and a similar flume as an outlet for water. In this pit, at the mouth of the outlet flume, is arranged a complete set of baffling apparatus, or trays, placed in a vertical position. The object of this is two-fold: to handle or retard the flow of water to the greatest possible extent, and secondly, to act as a skimmer and hold the carbon in the pit. The larger the pit area, the better the results, as our experience shows that settling pits, to obtain the best results, must contain a large area, but, on the other hand, must be shallow. The water and carbon in these settling pits should be as nearly motionless as possible. In large plants the best results can be obtained by a system of pits, three in number; the first pit receives the carbon and water, the second is drying out, while the third is dried and is being emptied. The water, as it leaves the pit that is being filled, can be conserved and pumped over a cooler and used as many times as desired. This is advantageous in localities where water is not plentiful.

From the settling pits the carbon may be taken, by means of either teams or mechanical conveyances, and placed on a final drying ground; or, in places where plenty of space is available for sun drying, it may be pumped from one pit as fast as settled, and by so doing, the necessity of a system of settling pits is obviated—only one pit being required to conserve the water. The carbon having arrived on the final drying ground is in a position to be dried by the action of the atmosphere. This natural drying process is usually assisted by hauling a heavy roller over the pile of carbon; this forces the moisture from the pile to the surface, where the sun and wind cause it to be rapidly evaporated. The rolling process also leaves the carbon in more solid, compact form, so that it may be used for smokeless boiler fuel or water-gas generator fuel without pressing or bricking. When weather conditions will not permit of sun drying, the carbon may be artificially dried by a mechanical dryer.

The carbon may be carried by means of teams or mechanical conveyors to a briquet press, to be made into a domestic

fuel, or to a brick machine, making fuel brick the size of an ordinary building brick. In the latter form it is very desirable as a fuel, but costs little more than in lump form. When containing between 20 and 30 per cent of moisture at the time of pressing, and with no other binder, carbon produces a briquet or brick which, when properly made and cured, is a solid fuel the superior to which is not to be found on the Pacific Coast. It makes a splendid grate, cook-stove, base-burner, or boiler fuel. The objection might be raised that this fuel, without any binder, would not stand shipment. We find by trial that a briquet pressed from carbon containing no binder, but about 20 to 30 per cent of water, and then well dried, will stand a great deal of handling.

The manufacture of the carbon into briquets is done by means of an ordinary pressed-brick machine having mold and dies of a cylindrical form. The most satisfactory size that we have found is 2¾ inches in diameter by 2¾ inches deep. Some prefer the same size of briquet with a conical top, but there is little difference. The ordinary pressed-brick machine with mold and dies of cylindrical form, making, say, twelve briquets to the revolution, turns out a good article at a very reasonable figure. Those in authority recommend them as a good fuel, evaporating as many pounds of water to the pound of fuel as does soft coal. It is safe to use these briquets in a city with a stringent smoke ordinance, for with very little care they may be burned in small boiler plants, with no smoke.

When manufactured in the form of bricks, carbon is particularly adapted for large furnaces in residences, for large boilers, and as a generator fuel for water gas. An ordinary pressed-brick machine with mold and dies making bricks 9x4x2½ inches is used, with no binder other than the 20 to 30 per cent of moisture contained in the carbon at the time of pressing. After these bricks are cured they make a better fuel for the purposes mentioned than the briquets.

There is still another type of press which, for making fuel for use around the gas works, either in water-gas generators or under boilers, is the best adapted of all. It is a machine of a plunger type, that is capable of subjecting the material to an enormous pressure and turning out a brick by what might be termed a "continuous" process. The brick, as we use it, is about three inches square and has no regular length, as it would require still another piece of apparatus to make the bricks in regular lengths. By using a trough at the outlet of the plunger die, leading from here to any point desired, or where the product is to be used, the bricks will break off in uneven lengths by falling over the end of the trough. With the machine in use by us, these pieces furnish, practically, three-inch cubes. The dies of the machine may be made of any size, of course, but we find the above-mentioned die gives the best results.

Carbon, when mixed with 40 per cent of pitch or tar, is a valuable smudge fuel for frost protection in the orange belt, making not only a dense smoke on account of the added tar or pitch, but a good heat as well, and it is a slow-burning fuel. To illustrate the slow-burning qualities of carbon, it is necessary only to fill a grate with briquets and after the fire is well started add a few more. The briquets will burn for three or four hours, holding their perfect shape during all of this time, and not until they are completely burned out will they lose it. When entirely consumed they will suddenly break up into a powder, leaving a very small percentage of clean ash. The ash in carbon is very slight, being from 1 to 5 per cent.. This is true of carbon fuel in any of its different forms.

In closing, I might say that this is merely a word sketch, telling the story as briefly as possible, hoping that it may be of benefit to some who are still struggling with the question. We do not claim, by any means, to have settled the problem of handling the product. The above is given simply as the result of many trials and experiments, disappointments and successes, during the past five years.

PURIFICATION PROBLEMS.

By E. L. Hall.

Ever since the advent of illuminating gas, the presence of sulphur in the gas-making materials has resulted in varying quantities of sulphur derivatives in the crude gas.

These consist, besides sulphuretted hydrogen, of bisulphide of carbon, thiophene, mercaptans, sulphocyanides, and other sulphur combinations, not all of which have been identified.

All of these sulphur combinations burn with air to form sulphurous and sulphuric acids. Gas from which they have not been at least partially removed cannot be used without great discomfort. Moreover, the constant inhaling of these fumes will produce a chronic irritation of the mucous membrane and lining of the breathing passages, predisposing to diseases of the lungs and throat. Nor are the effects confined to discomfort and personal danger; nearly all metallic objects, such as gas appliances, fixtures, etc., are easily and thoroughly corroded, and goods such as hangings, wallpaper, etc., are bleached and faded.

Sulphuretted hydrogen, comprising the bulk of these impurities, is very completely removed by all the gas companies.

It is to be regretted that the gas industry has done so little to reduce the amount of the organic sulphur remaining in the gas after purification from sulphuretted hydrogen. Consumers have squirmed and electric companies have rejoiced, and the phrase "evil-smelling gas" has stuck, to the hindrance of gas sales and to the loss of the gas companies.

In either coal gas or water gas made from very sulphury materials, the organic sulphur attains very formidable proportions. In some places, a maximum limit has been imposed, usually at from 20 to 30 grains per 100 cubic feet. By the partial removal of the carbon bisulphide, those companies under restrictions manage with much trouble and at considerable expense to keep under the limit.

This is effected by the use of "sulphided lime," but with the greatest irregularity and uncertainty, and with the added danger of at times increasing instead of reducing the amount of organic sulphur. The spent material is a great nuisance and source of expense for removal. However, no better method up to the present time has been worked out, although a gas chemically pure from sulphur would be a great boon to the industry.

It is believed that a step in advance, leading perhaps to a solution, or at least to a better understanding of the problem, has been taken by the company with which the writer is connected, the Portland (Oregon) Gas Company.

This company manufactures its gas by the so-called "crude-oil water-gas" process, as generally used by the gas companies of the Pacific Coast.

As is well known, most of the crude oil coming from California contains very appreciable amounts of sulphur, and therefore, as would be expected, the amount of organic sulphur in the purified gas is quite high; so high, in fact, that much discomfort has been experienced by the gas-using public in all of the coast towns.

In perfecting an apparatus to eliminate this trouble, two years of experimentation were necessary.

It had first to be shown that the organic sulphur is of the same nature as that in coal gas. Theories then had to be worked out to account for its presence and for its behavior.

Study of the cause of formation of the organic sulphur has been attended by the same difficulties that have made naphthalene investigation so perplexing. The reactions in gas manufacture, even more than in other chemical industries, are deep seated and little understood.

It has not always been possible to ascribe any one variation to any one particular cause. It has often doubtless happened that the effect of one cause has been to neutralize and mask the effect of another cause.

Among the factors that we find to influence the amount of organic sulphur present in the purified gas are the percentage of sulphur in the raw material, the gas-making temperature, the accumulations of tar and oil in the works, the condition of the purifying material, and the amount of washing and scrubbing.

Excepting of course the percentage of sulphur in the oil, we have not been able to vary any of these factors sufficiently to appreciably reduce the amount of organic sulphur.

In regard to the purifying material, it has been frequently observed that the purified gas will regenerate traces of sulphuretted hydrogen in the unpurified box. This action may be explained by the presence of cyanides in oil gas amounting to from 50 to 60 grains per 100 cubic feet. Another theory to account for this action would be the presence in the purifying material of amines, with which the carbon bisulphide would react as follows:

$$CS_2 + 2C_6H_5.NH = CS\begin{matrix}NH.C_6H_5\\NH.C_6H_5\end{matrix} + H_2S$$

In other words, sulphuretted hydrogen and thiocarbanilide would be produced, which latter may decompose in turn to form phenyl mustard oil and aniline. The aniline is again capable of repeating the cycle. That some such action is taking place in oxide for oil-gas purification has been many times verified and it is thought to be closely connected with organic sulphur.

For removal of organic sulphur, the old "sulphided-lime" method was first resorted to, but was abandoned because of the high cost and uncertainty attending its use.

This was followed by attempts to vary the operating and purifying conditions, with but meager results.

Different chemical substances have been tried as solvents in the laboratory, with varying success and always at a cost prohibitive on a manufacturing scale, for the cost of the solvent and operation must be less than the difference between that of oil gas and the next cheapest process with no organic sulphur.

The last and most promising of all methods tried was the passing of the gas through red-hot tubes in order to break down the organic sulphur to H_2S, with subsequent easy removal by oxide of iron purifiers.

The first experiment was performed in a piece of hard glass tubing heated in a combustion furnace. Purified gas was passed through and gave a stain on lead acetate paper. The glass was replaced by a piece of iron pipe, the heats raised, with even better results. The introduction of steam still further increased the efficiency. The process was set up on a small scale in the laboratory and was run for some time. The analysis of the reheated and purified gas gave as removed 66 per cent of the organic sulphur.

After this a small plant was set up consisting of, at first, a 30-inch C. I. pipe filled with scrap iron heated in a brick oven and connected to two 6x6-foot purifiers. The gas was taken from the station meter outlet and discharged into the storage holder.

Owing to the large size of the pipe, the best result that could be obtained steadily was 50 per cent removed at a rate of 15,000 cubic feet per hour.

This arrangement was replaced by five 4-inch tubes and eight 3-inch tubes, 8.5 feet respectively, with a total heating surface of 126.5 square feet. The results with these tubes were much improved. Various rates of flow and amounts of steam were tried as tabulated below:

19700	None	350	662	15
17000	½ open	460	860	15
15000	Full	500	932	25
14200	½ open	410	770	50
10200	½ open	520	968	50
Average 15280		448	838	31

These results could undoubtedly have been bettered with still smaller tubes, giving better contact. Also by retainers in the tubes to disseminate the heat and impart a mixing motion to the gas, but the heat destroyed the iron pipes too rapidly and the iron tubes were abandoned in favor of an internally heated apparatus.

The chemical action taking place is thought to be the reverse of that taking place in the generators, or

$$CS_2 + 2H_2 = 2H_2S + C$$

or, if the hydrogen be derived from water vapor,

$$CS_2 + 2H_2O = 2H_2S + CO_2$$

and similarly with the other combinations of sulphur.

When operating at low temperatures, varying percentages of the total will be decomposed according to the effective heat. After purification a second reheating will decompose a further portion. If the same temperature is maintained during both reheatings the same proportion would be removed each time, i. e., say 2/3 the first time, then again 2/3 of the remainder, and so on.

It is thus seen that for any one temperature there is a balance established between the organic sulphur broken down and that remaining, and this balance shifts as the temperature increases in favor of breaking down a larger proportion of the whole. And for any one temperature this balance will persist until a part of one side of the equation has been removed, i. e., until, according to the law of mass action, the concentration on one side is reduced, enabling more atoms to pass over to that side in unit time than can return, when a new equilibrium is established. This, in turn, will persist as in the former case. Therefore, to remove the organic sulphur at a low temperature several reheatings and purifications would be necessary. At a very high temperature most of the impurity is broken down with one reheating. For these reasons also the gas should be purified before the first reheating.

Since the experiment revealed the unsuitability of iron tubes to reheat the gas, an apparatus was designed to handle the output of the works.

The apparatus consists of two firebrick-lined shells filled with staggered checker-brick similar to the ordinary water-gas superheater. Between these two is another shell similarly lined and filled, but about half as high. This shell or generator is equipped with oil burners or solid fuel for alternately heating up the two gas reheaters. For this purpose the generator is connected up on either side by hot valves with the bottom of the reheaters. The latter are provided with the regulation stack valves and off-takes dipping into a common wash-box. The purified gas is admitted alternately to the bottom of each reheater and goes through the hot brick, where the organic sulphur is broken down into sulphuretted hydrogen. After passing through the wash-box the gas is passed through a scrubber and then through secondary oxide of iron purifiers.

In this process the brick are maintained at a cherry-red heat, and at this temperature (700-900 Cent.) the organic sulphur is almost completely broken down.

Remaining after a second purification will be only traces of organic sulphur.

At this temperature the candle power does not seem to suffer at all. However, in oil gas-making this is a matter of indifference, for lower heats can easily be carried in the gas

generators, making the gas just rich enough to offset any loss in the reheaters, and of course at the same oil per thousand in either case.

It has not been found necessary to introduce steam into the reheaters as aqueous vapor is normally present in the gas in sufficient volume to furnish nascent hydrogen for the reaction.

The plant has now been operating steadily and the organic sulphur is broken down with great certainty.

In conclusion, the following theory is offered to cover the facts as set forth in this paper. The formation of carbon bi-sulphide in the generator may be conceived as being due to a reaction between the H_2S and carbon produced by decomposition of the oil, according to the following equation:

$$2\ H_2S+C=CS_2+2\ H_2$$

When one considers that sulphur and oxygen are of the same chemical family and act analogously in many ways, we see at once the counterpart of the well-known water-gas reaction,

$$2\ H_2O+C=CO_2+2\ H_2$$

which strengthens our theory. The fact that the water-gas reaction increases in efficiency with the rise of temperature argues for the same effect in the analogous CS_2 reaction. In other words, we would expect that a larger proportion of the total sulphur would appear as CS_2 with higher heats and this has been the universal experience of gas men. In the vertical retorts, as at Dessau, where the gas is not exposed to overheating as in the horizontal retorts, lower CS_2 has been found.

For any one temperature effect, therefore, a certain definite ratio of H_2S to CS_2 may be expected. In oil gas conditions and temperatures it may be taken as something around 8.5 to 1.

It is to be expected that a point may be reached in temperature where the ratio will no longer increase, and may, in fact, decrease. In the reheating effect we have merely the necessary readjustment to this same ratio after the removal of one side of the equation and the restoration of the temperature of reaction.

GAS MANTLE IMPROVEMENT.

From Consul-General Richard Guenther, of Frankfort, comes the following summary from German journals of the use of artificial silk for gas mantles:

The Didaskalia states that the Welsbach mantles for gaslight were hitherto prepared by saturating the mantles of woolen or ramie fiber with a solution of rare earths, which produce the increased light. Experiments to substitute silk, hemp, or jute proved unsuccessful. Artificial fibers did not become saturated, or insufficiently so. According to the Moniteur Scientifique an artificial fiber has now been found which in all respects is equal to wool or ramie, namely, artificial silk, which is produced by dissolving cellulose in an ammoniacal copper solution. Only the nitrate of thorium does not answer well as a saturant. While artificial silk becomes impregnated with a solution of that salt, the oxide of thorium formed through incineration scales off and nothing but a bit of powder remains. Therefore instead of nitrate of thorium, hydro-oxide of thorium must be used, which after incineration leaves a perfect, solid skeleton of hard little crystals.

As however, hydro-oxide of thorium is of a gelatinous consistency, the mantle of artificial silk cannot be impregnated with it, and therefore it is first saturated with nitrate of thorium, and, through the action of ammonia, hydro-oxide is formed upon the fiber. One of the greatest advantages of this new mantle is that it is not hydroscopic and is of greater durability.

Experiments have demonstrated that even two to three thousand shocks do not injure it, while the best mantles prepared by the old methods did not survive more than 90 to 100 shocks.

THE STEAM TURBINE.

Discussion by members of the San Francisco section of the American Institute of Electrical Engineers of paper read by Mr. F. E. Vickers, as published in the "Journal of Electricity, Power and Gas" of September 5, 1908. The following members participated in this discussion:

P. M. Downing, Operating Engineer, California Gas & Electric Corporation, Chairman pro tem.

F. E. Vickers, Expert, General Electric Co., San Francisco.

K. G. Dunn, Hunt, Mirk & Co., San Francisco.

A. J. Bowie, Jr., Engineer, San Francisco.

R. R. Daggett, Electrical Engineer, Electric Storage Battery Co., San Francisco.

L. R. Jorgenson, Designing Engineer, with F. G. Baum & Co., San Francisco.

S. J. Lissberger, Electrical Engineer, California Gas & Electric Corporation.

H. Y. Hall, Jr., Assistant Electrical Engineer, Southern Pacific Co., San Francisco.

W. F. Lamme, Construction Department, Westinghouse Electric & Manufacturing Co., San Francisco.

B. C. Shipman, Consulting Electrical Engineer, San Francisco.

The Chairman: We have listened with a great deal of interest to Mr. Vickers' excellent paper, descriptive of the steam turbine, and I think we owe a vote of thanks for the time and labor he has put in preparing this paper. Mr. Vickers has shown us the good points of the Curtis turbine. We have with us the representative of another concern who also manufacture turbines; I would like to hear from Mr. Dunn.

Mr. K. C. Dunn: Mr. Chairman and Gentlemen: I do not know as there is much to discuss about this. There has been no engineering data or anything of that kind brought up. There is one point I would like to bring out regarding the Parsons machine. It may be briefly stated that our clearances are very, very small, but Mr. Vickers failed to state what his clearances were. Our regular clearances in the smallest sizes, the minimum between the spindle and the cylinder is a fifty-thousandth of an inch. It would hardly be polite for me to state what the clearances are in the Curtis machine, but in the smaller sizes it runs about ten-thousandths, and in the larger about twenty-thousandths.

As regards the dummy pistons, they are put in to absolutely balance the machine, in order to prevent any end thrust. As regards the Curtis machine, I believe Mr. Vickers stated that the pressure on each side was absolutely balanced. I hardly think that can be found to be the case in practice. In any single-stage machine, where you expand down to the final pressure, this would be the case; but it seems to me that where you expand down to say seventy or eighty per cent of the pressure, as I understood Mr. Vickers, there is bound to be a further expansion in passing through the blades, which would make a difference in pressure between the top and bottom of each stage.

The principle of the steam turbine is quite similar to that of a water turbine, with the exception that with water the nozzle is contracting and with steam the nozzle is the reverse. In a single-stage machine the steam expanded, say, from one hundred and fifty pounds to twenty-eight inch vacuum, the velocity exceeds four thousand feet per second. This would mean in any single-stage machine a nozzle velocity of four thousand feet per second. In any two-stage machine or four-stage machine, the nozzle velocity would be approximately two thousand feet per second. In a Parsons machine, the maximum velocity in the low-pressure end is six hundred feet per second; and in the high-pressure, four hundred feet per second; which gives an average velocity of five hundred as against two thousand feet velocity in a two-stage, three-stage, or four-stage Curtis machine. The cutting action is as to the square of the velocity. The real prime difference between a steam turbine and reciprocating engine is in the possibility of taking advantage of the lower ranges; that is, from 180 pounds gauge

to 28 inches vacuum we have approximately 154 expansions; from 180 pounds gauge to 29 inches, we have approximately 340 expansions. In an ordinary compound engine, with quarter cut-off and cylinder ratios 4 to 1, we have 16 expansions. You can readily see what it would mean to design an engine that would take advantage of all possible expansions. Probably the best type of compound reciprocating engine we have today expands down to four or five pounds absolute; while the turbine can be designed to expand down to 28 or 29 inches vacuum—say, one pound to half a pound absolute. If you would design such a reciprocating engine, it would be commercially impracticable. We will assume that from 150 pounds to 28 inches vacuum would represent 100 per cent. If you should take that to atmosphere, it would represent 50 per cent; taking it in what would be good practice in engine design, it would represent 75 per cent efficiency. Now, a turbine can take advantage of this difference; they expand down to 29 inches vacuum and take advantage of that 25 per cent difference, which means considerable.

There has been a good deal of talk about the reciprocating engines being able to produce as good results as the turbine. If you will take the highest type of compound engine, under ideal conditions, with pistons in good shape, and rings expanded out, your valves scraped—everything absolutely tight—you can take that same engine and put it under a ten or twenty-four hour test and it will gradually drop down in economy. It drops down every day. That is not the case with the turbine. You can take the turbine, and the economy will increase for a certain period; the friction is reduced, due to a polishing action, and that turbine will show a better economy after a considerable period of run. Take on the other hand a reciprocating engine, and everything has to be in the pink of condition when you want to make the test. We do not find that to be the case when you make the test with the turbine, because we can get the same result after five days or thirty days, or even longer than that. In fact, we have one machine with which we had trouble after quite a period of operation, and the company who was operating it informed us that this machine had dropped off in economy because of the trouble. We were satisfied it was not the fault of the machine. We had guaranteed sixteen and three-quarters pounds of steam per kilowatt, and after the test it showed up fifteen pounds. We then thought it was a good scheme to have trouble once in a while. I used to sell steam engines, and up to five or six years ago we seldom heard of an engine doing better than fifteen pounds indicated; now we hear of twelve and ten and a half, and matters of that kind; but the engine man is getting the advantage of the customer. We used to sell engines and make guarantees on so many inches vacuum in the exhaust pipe and so many pounds throttle pressure. The man selling engines now talks about guarantees equal to turbine performances and says: "We will sell you an engine with so many pounds initial pressure, so many inches effective vacuum, and it will do so much." What is the result when we come to make the test? I know one test in particular, based on 165 pounds initial pressure; they had to have 182 pounds throttle pressure to get 165 pounds initial, with 98 per cent quality of steam. The results were corrected for 98 per cent quality of steam; but the actual facts were that the steam was wire-drawn from 182 pounds to 165. The steam was superheated and the engine got credit for heat units for which it should have been debited. On the other hand, the vacuum showed 27.7 at the exhaust nozzle of the engine and the card showed 24.8 effective vacuum. On a proposition of that kind, it is making the customer responsible for the builder's design. Now, the only difference in increasing the vacuum on the engine above what the engine is capable of expanding down to would be to relieve the back pressure. It does not increase the number of expansions. The reverse is true of the turbine. You can design turbines to expand down to any vacuum that you desire. Mr. Vickers brought out the question of floor space, which is quite a figure in a good many stations. At the present time it is a question of how you are going to place your boilers, instead of how you are going to place the engine. In the old type station you would run a double row of boilers and have plenty of room for your engines. Now it is the reverse. You have to run your boiler room at right angles to your turbine room in order to get any capacity. There is also a new type of station, where we have the turbine room above the boiler room. This is an ideal condition, because the live steam flows up and the exhaust steam flows down. We have two or three stations of that type. Our type of machine lends itself to this design because we require no foundation bolts and only a sufficient amount of foundation to support the dead weight. At the Los Angeles Pacific Company, they wanted to increase the station capacity, in which they had a 600, an 800, and 1,200 kilowatt engine driven units. They did not want to increase the size of the station, but had about 12 feet on one end between an engine foundation and the building wall foundation. They put in I-beams and installed a 2,750-kilowatt turbine. This shows the difference in the space required. In fact, a good many cases are quite similar.

The Chairman: The meeting is now open for discussion. We would be glad to hear from any one who has anything to say on the subject.

Mr. A. J. Bowie: Mr. Vickers, with reference to the leakage of air, on the high vacuum, 28-inch vacuum, is it necessary to provide a very much larger air-pump, and, if so, what is the relation between the amount of condensed water and the capacity of the air-pump? Also, with reference to the overload, what would be the maximum steam consumption of a turbine with the valve wide open with reference to the amount of steam taken at full load, and whether that steam consumption would increase very much when the speed fell off?

Mr. Vickers: In regard to the air leakage, that is very small in any event. The carbon packing at the high-pressure end is under pressure from within, except at light loads, when there is a vacuum in the first stage. Then a steam seal is used. The carbon packing casing at the step-bearing end of the shaft is furnished with a steam seal, through a reducing valve giving at all times a pressure of four or five pounds per square inch to prevent any air getting in at all. The joints in the casing are air tight, and there is practically no leakage.

As to the steam consumption, at the Chicago Edison plant some 8,000-kilowatt machines there were given a test, and they gave 12.8 pounds of steam per kilowatt-hour delivered at the switchboard; and from 5,000 to 11,000 kilowatts the variation in economy was less than five per cent—the curve was almost flat.

The Chairman: Has anybody else anything to say on this subject?

Mr. R. R. Dagget: What is the maximum amount of overload a turbine will take?

Mr. Vickers: With a 5,000-kilowatt machine, about half of the valves would be open when carrying 5,000 kilowatts load with 28-inch vacuum; with a maximum rated machine, having a generator large enough to carry the entire capacity of the steam turbine when running condensing with a 28-inch vacuum, the non-condensing capacity of the steam part is probably 60 per cent of the maximum.

Mr. L. R. Jorgenson: The economy of a triple-expansion engine is practically the same as that of a turbine of the same size. If indicator cards are taken from a triple-expansion engine and re-plotted to the temperature entropy scale, it is plainly seen that cards taken from the two first cylinders, high and medium, cover nearly 80 per cent of the ideal area. The low-pressure cylinder diagram covers 45 per cent only. Therefore it is evident that the high-pressure cylinders (high and medium) can transform the heat in the steam into work more efficiently than a steam turbine, and with low pressure the turbine is so much ahead of the last engine cylinder that they finally come out even, or the turbine slightly ahead. To ascertain the maximum economy, it would be necessary to combine the two prime movers in such a way that each was worked on the portion of the cycle most economical for it.

Steam expanding from 150 pounds gauge to 28 inches vacuum has approximately 100 times greater volume at the end of expansion than before; if expanded to 29-inch vacuum, it has about 200 times greater volume. A steam turbine can take care of this great expansion, whereas it is not practical to make a steam engine take care of expansion more than down to 24 inches; we get too little extra work out of the steam at the expenditure of large quantities of cooling water by installing condensers which will give much higher vacuum than can be used. The high and medium pressure cylinders are able to take care of the expansion; the dimensions are relatively small; therefore, friction and cooling losses are not large, and therefore their efficiency is better than the high-pressure portion of the turbine. That the turbine finally comes out a little ahead is due to the fact that the low-pressure portion of the same is so much more efficient than the low-pressure cylinder of the steam engine. The reasons are several: The discs rotate in a nearly perfect vacuum; therefore, windage losses are small. The steam friction loss is proportional to the specific weight of the steam, which makes this loss many times smaller in the low-pressure stages than in the high-pressure stages.

The loss due to leakage through clearances is also proportional to the density and therefore much the largest in the high-pressure turbine. The density of steam is about fifty times greater in the first stage than in the last; but it must also be remembered that leakage takes place only on 15 per cent of the circumference in the first stage, whereas in the last stage the leakage takes place all around the whole circumference.

The increase in economy of a steam engine is nearly proportional to the rise in boiler pressure. This is not the case with turbines, where leakage losses increase fast with higher pressure. The economy of a turbine increases fast with improved vacuum; the economy of a steam engine does not.

In order to obtain the most economical condition we would have to take a two-cylinder compound reciprocating engine and feed it with a boiler pressure as high as practical—say, 225 pounds gauge—and 200 degrees superheat, and let it expand down to atmosphere in the engine; from there it is exhausted into a low-pressure turbine, where it expands to 28 inches or 29 inches vacuum. In this way an efficiency of up to 24 per cent can be gotten out of the steam. The best efficiency of a single unit is now 12 per cent to 15 per cent.

The Chairman: Has any one else anything to add?

Mr. S. J. Lissberger: Did I understand Mr. Jorgenson to say that the increase in vacuum continued to increase the efficiency of a steam engine, and if so, up to what point?

Mr. Jorgenson: Up to 24-inch vacuum. It is not practical to have a larger vacuum, for the reason that the cylinders are not large enough to take care of the expansion. If you expand steam from 150 pounds to 28-inch vacuum, it expands 100 times. It does not pay to make the engine cylinder take care of an expansion down to more than a 24-inch vacuum; the dimensions would be so large that the extra gain would be eaten up in additional friction and cooling loss.

Mr. Lissberger: Do not steam engines today work more than that?

Mr. Jorgenson: Yes, they work to 26 or 27 inch vacuums, but you do not get much work out of the extra inch or two; you have to supply a lot of cooling water.

Mr. Lissberger: You bring the theoretical efficiency up that much?

Mr. Jorgenson: You bring the efficiency up a little, but it is very little.

Mr. Lissberger: You bring it up according to the old formula , and it holds up.

Mr. Jorgenson: The efficiency is but the temperature t is that due to a 24-inch vacuum, as the low-pressure cylinder can only expand the steam so far; it has no more volume; the steam must be cooled off by means of cooling water in the condenser from temperature t to the temperature corresponding to the vacuum in the condenser—the heat does not do work; the cooling water takes it away. It is true the back pressure is less, but this advantage is nearly offset by the cooling of the cylinder walls to a lower temperature than t; this loss the admission steam will have to make good.

Mr. Dunn: I think this engine proposition resolves itself down to simply this: An ordinary engine will expand down to a certain absolute pressure, and the only difference that a greater vacuum than that may be, will be in relieving the back pressure; it does not increase the amount of expansion; that is fixed by the cut-off and cylinder ratios. I wish to take issue with Mr. Jorgenson on the statement regarding the increased pressure on a compound engine. That is at variance with all of the principal builders. There is very little advantage gained in a compound condensing engine above 165 pounds pressure. It is also a fact, which can be proven by figures, that a compound engine exhausting into an exhaust turbine would increase the economy, but I do not think there is anybody that would want to install a new station of that kind if they figured out the first cost of it. It might be ideal, but taking the cost of that station, the compound engine and turbine, it would figure out poor economy. A straight turbine engine would beat it all hollow, because the total charges would be less, and that is all we are arguing on; it is not a commercial proposition, even if it is an ideal one. We are arguing about what we can get for our dollars and cents, what the current cost is.

As regards 200 degrees superheat: In Europe, a good many engineers run up to the high degrees of superheat, but I do not believe for a total over-all station economy there is much to be gained by over 100 degrees superheat when you take everything into consideration. From the standpoint of the engine salesman, high superheat is a good talking point, but that is not what we want; what we want is over-all station economy. Superheat costs money; you do not get it for nothing. As you run up into the higher degrees of superheat, it costs you money to get it; and when you figure it at about 100 degrees that is the best over-all station economy.

The ideal conditions, in my mind, provided you have a proper fuel condition, would be, as Stott pointed out before the institute a couple of years ago, a combined gas engine and turbine station, utilizing the exhaust from the engine for heating water, and when you come down to an over-all station efficiency, where you have the proper fuel condition, that would be an ideal plant, but we have not the proper fuel condition on the Pacific Coast for that sort of combination at the present time.

Mr. Jorgenson: I agree with Mr. Dunn. I forgot to say or to add when I said "increase in efficiency," a station of that kind would be built only when the inconvenience and expense of having two units of different kinds would be more than offset by increased cost of fuel.

Mr. Dunn: I retract my statement.

Mr. Jorgenson: The coal and oil would have to increase in cost before a station of that kind will be built, but I suppose it will be built some day.

Mr. Dunn: Somebody might be foolish enough.

Mr. H. Y. Hall: I would like to state that Mr. Stott intends to install in the Fifty-ninth Street station of the Interborough Railway Company a turbine. At present the station contains ten Allis-Chalmers old Manhattan type engines with a vertical and horizontal cylinder. The high-pressure cylinders are 44 inches in diameter. The low-pressure cylinders are equipped with Corliss valves. I received a letter some time ago from one of Mr. Stott's men, in which he said that Mr. Stott was going to install turbines in his station.

Mr. Dunn: That simply bears out my statement that where you have an engine plant installed, it is economy to install exhaust turbine engines and increase the efficiency of the station, but I do not think you will see any new plant installed with steam engines and exhaust turbines.

Mr. Jorgenson: They operate with superheated steam at 175 pounds pressure.

Mr. Hall: The test of Mr. Stott on that proposition showed 15.9 per kilowatt; it was not very high superheat, though.

Mr. Jorgenson: The growth of the steam turbine industry has been enormous in the last six or seven years, and I do not see why the use of these compound units should not amount to something some time. When I came to this country about seven years ago, the first decent job I got was with Curtis in Schenectady. He was just trying to sell out his patents to the General Electric Company. I regard myself as a General Electric man, but I have been long enough out of that atmosphere to be able to see straight again. (Laughter.) Neither General Electric men nor Westinghouse men are able to see straight. (Laughter.) When I started in the department there—there were two before I came there. We started with Curtis turbines with horizontal shafts; and all at once the General Electric Company got a contract from the Chicago Edison Company for three 5,000-kilowatt units. I never saw such nerve before for those people to take such a contract as that when all they had was a little dinky engine running in their testing department. All we had to do was to go down in the testing room and try to find out what data we could get. Mr. Curtis knew a lot of theory, and we were more or less guessing at it. The machine was finally built and fixed and put up, and it is running now. I do not think they made much money on that machine, but they have made lots and lots of money since. The shop where it was built was a little wooden shanty 2x4. Half a year later there was a shop 265 feet wide and about 800 feet long, ready to receive the turbine department, and they went at it in great style. I was not in that department more than half a year; when I left there were twenty-five in the department trying to design steam turbines that would run; and when I left Schenectady two years afterwards they had two great shops for turbine construction.

When I came over here tonight, I thought we would have a step-bearing scrap, but that has not come off yet. In the matter of economy, the Curtis turbine and Parsons turbine are pretty nearly alike, as far as I have been able to find out. I have been studying the question ever since I left Schenectady, and I think for the same size the economy is pretty nearly the same for the two types. I like the step bearings, and I never saw or knew of anybody who had any trouble with them, and as far as friction is concerned, they run almost without friction. The Parsons turbine has got the advantage of the low steam velocity, and therefore it does not need superheat. The Curtis turbine needs the superheat. The erosion of the blades does not amount to much in either of them, and if the Curtis turbine is used with superheat, the blades will last just as long as in the Parsons turbine, I think.

Mr. Vickers: Mr. Dunn questioned the statement as to the equal pressures on both sides of the wheel in the Curtis turbine. Each wheel is in a separate stage between two diaphragms, and there are large holes through the wheel disc, and nothing to prevent the flow of steam around the edge of the wheel, so that the pressure must be the same on both sides of the wheel; the entire stage pressure is the same throughout. Mr. Dunn's statement in regard to clearances is somewhat misleading, because he has compared the radial clearances of the Parsons type turbine with the axial clearances of the Curtis turbine. In the Curtis machine the radial clearances are so large that they could hardly be considered clearances, reaching in some sizes two or three inches, and the axial clearances vary from about 0.070 inch in the smaller machines up to 0.200 inch in the larger sizes, being ample to prevent contact between the rotating and stationary parts.

Mr. Jorgenson: The steam pressure in the different stages in the Curtis turbine must be uniform, because the steam expands only in the nozzle. That is the reason that the leakage losses in a Curtis turbine must be slightly less than the leakage in the Parsons turbine. In the Parsons turbine you have a difference in pressure between all rotating and stationary blades, and therefore there must be a little leakage—or, the chances are that there is a little leakage between the blades; and that could not be the case, at least in a large degree, in the Curtis turbine. That they come out even in economy is because the steam friction loss is less in the Parsons turbine.

Mr. Dunn: It is a pretty hard proposition to conceive how there could be excessive leakage losses in the Parsons turbine about the ends of the blades. With the blades that are put in the Parsons machine, it is hard to see how steam could go from end to end of that machine and not do useful work. As regards the Curtis machine, there is a lot that I do not know about it. It seems to me in a single-stage machine, when you are expanding through the nozzle to the maximum velocity, you have then got equal pressures on both sides of the disc. But where you have a multi-stage machine, the steam will not expand down to a maximum velocity; that is, where you have a 100-pound pressure and you expand down to 58 pounds, you have the maximum velocity; if you expand down to 70 pounds, you have not the maximum velocity, and it seems to me if you are expanding to 70 per cent of the pressure that the steam passing through the blades is bound to expand and on the other side of that disc you have a lower pressure than when you started in; there is bound to be a difference in pressure, it seems to me.

Mr. Vickers: That would apply only to the small section of the buckets immediately below the nozzles, but the wheel disc itself and the remainder of the buckets on the periphery of the wheel would not come under that difference of pressure. In the first stage the nozzles cover about 15 per cent of the buckets, and the other 85 per cent of the buckets would have the same pressure on both sides.

Mr. Dunn: How about the reduction of velocity that takes place? You start in and at the nozzle you have 2,000 feet velocity; then you have 1,100 feet velocity at the second blade; and at the third blade you have 500 feet velocity; the steam is bound to expand, and it seems to me you are not going to have absolutely the same pressure on both sides. I can see how in a single stage you would have the same pressure, but I do not see how you get it with a multi-stage turbine. I am simply looking for information.

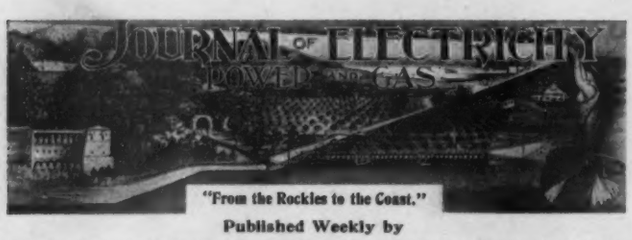
Mr. Vickers: You might get a slight difference right under the nozzles, at the actual periphery of the wheel. Everywhere else the pressure is the same; there is no expansion in the buckets themselves; and even if there were the amount of difference of pressure there would be very slight, owing to the small area covered.

Mr. Jorgenson: I suppose it would not be polite to ask the gas company to furnish us with a blackboard; if they did, it would be easy to show that there was no expansion after the steam leaves the nozzle. Suppose you take 150 pounds pressure at the nozzle; the nozzle has the smallest diameter nearest the top and the larger area towards the runners. As soon as the steam enters the throat, that is, the small opening, it expands to a pressure 58 per cent lower than the boiler pressure, and it gets the velocity of 1,480 feet. How much the boiler pressure is does not make much difference; the velocity will be between 1,400 and 1,500 feet. Suppose we want to take up an equal amount of work in the four stages, taking a four-stage turbine; we divide the diagram in such a way that each stage gives us one-quarter of the work; therefore, we find that we must have a pressure in the first stage of, say, 75 pounds; we figure out the expansion ratio and the area of the orifice to give us this pressure.

At the orifice we have a velocity of 1,780 feet per second. Now, the steam jet turns around three or four times while going through three moving vanes and two stationary vanes; and it does not expand in either of them, but it gives off velocity, which is the same as work.

Going through the first set of rotating blades, it loses about 300 feet in velocity. Flowing through stationary blades, it does not do any work and it does not lose any in velocity, and it does not increase in velocity, because there is no expansion; the buckets are made so that there will be no expansion; the entrance area must be the same as the outlet area.

(*Continued on page 192.*)



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STEAM TURBINE VERSUS RECIPROCATING ENGINE.

Elsewhere in this issue some comparisons are made as to the relative efficiency of the steam turbine and the reciprocating engine. This is as yet a moot question, as fruitless as it is profitless. A new record for economy set by the reciprocating engine today will be duplicated by the steam turbine tomorrow, and vice versa. Each possesses certain advantages. The reciprocating engine works best at high pressure; the turbine works well below atmospheric pressure, the lower pressure being obtained by the aid of certain auxiliaries such as vacuum pumps and condensers.

This naturally suggests that the ideal of economical steam consumption would be obtained by the combination of a high pressure reciprocating engine with a low pressure turbine utilizing the exhaust. Such is now being successfully accomplished by English ship builders and is being considered for a number of plants in this country, particularly when the output of existing reciprocating engines is to be increased. Exhaust steam is usually supplied to the low pressure turbine at fifteen pounds absolute pressure and a vacuum of twenty-eight inches. The same amount of power can thus be obtained from the turbine as from the reciprocating engine, thereby doubling the power without increasing the fuel consumption.

AN UNJUST CHARGE.

During the past four years this country has heard a great deal about rate discrimination, rebates and other improper devices through the operation of which one individual obtains an undue advantage over another. Public opinion has very properly supported and encouraged the administration in its very vigorous efforts to check these discriminations. There lives within the great body of people an overwhelming sentiment that disapproves of injustice. The ordinary man does not complain of governmental burdens so long as all are treated alike.

It is therefore somewhat surprising to find a branch of this same administration visiting unequal burdens upon hydro-electric companies in the West, practically committing the same wrong that brought the Standard Oil to the bar of justice. The discrimination consists of this: Irrigation companies are granted a free right of way for ditches and canals through forest reservations. This is right; it should be so, although these ditches do take and irretrievably consume the water. Grants of rights of way for railroads and wagon roads are authorized by act of Congress. This, too, is right. The government should encourage development, not retard it. An absolute grant of right of way for canals and ditches, pipe lines and tunnels through forest reservations is given for municipal purposes, for mining purposes, for milling purposes, and for the reduction of ores. This, too, is right and proper, and sounds a true policy of development.

If these free grants are predicated upon a policy of equality, upon the broad ground of assisting State development, as they are, then they are justified, even though the grant means an absolute taking and consuming of the other resources of the State. But if these grants are right, then the withholding of the same privileges from hydro-electric companies is emphatically wrong. If the attitude of the government toward the power companies is right, then all of their other concessions are wrong.

The government is attempting to not only charge the power companies for the use of land for rights of way and for other purposes, but is attempting to levy a tax on consumers for a mere right of way on the total current output of the company, even though that current be generated on their private property.

If an unnecessary arbitrary and expensive burden is placed on a public service corporation, who pays for it? If the Secretary of Agriculture chooses to inflict onerous penalties upon the hydro-electric companies of the West for the purpose of re-foresting watersheds in other States that have been stripped of their forests, who pays for it? The people of the Western States. The electric power company is merely a collection agent for the government. When a new expense is added to the cost of producing an article, a pro rata increase of the cost of that article to the consumer is the only recourse for the corporation. The rates go up. The company collects the increased tariff and pays it over to the government. The people pay it.

All of this is very elementary, but it would seem as though it were necessary to get down to fundamentals in discussing this question. If it is wrong for a railroad to grant rebates to the Standard Oil Company and refuse them to another shipper, the wrong grows out of the fact that the advantage given one shipper is equivalent to adding a burden on the other. If in place of giving the Standard Oil a rebate, the railroad should ship at the regular tariff but add something to the toll charged others, the wrong would be there and be punishable. Every burden placed upon a public service corporation is a burden placed upon the community served by that corporation. This is a fundamental principle frequently lost to view in a general scramble to punish such corporations.

Take a power company for example. If on one hand we have the State with broad powers of taxation, not always equitably administered, and standing beside it we have the federal government exacting a pound of flesh by way of heavy charges for permission to do business, then couple up these two forces who have the first whack at the treasury, with local governing boards in cities and counties who have the power to regulate rates, and you will have placed the investor between the upper and the nether millstone of governmental control.

PERSONAL.

Henry F. Frosch, of Henry F. Frosch & Co., of San Francisco, has returned from a trip throughout Southern California.

F. H. Poss has returned to San Francisco aften an extended trip East, where he attended the annual Holophane convention. He is now in Los Angeles.

W. R. Layne, formerly with the Geo. J. Wellington Co., of San Francisco, has joined the incandescent lamp sales force of the General Electric Company in San Francisco.

Ralph L. Phelps, manager of the San Francisco office of the Safety Insulated Wire & Cable Company, has returned from a ten days' trip to Los Angeles. He reports that business is good.

BOOKS RECEIVED.

In "Practical Irrigation," Mr. A. J. Bowie, Jr., presents a comprehensive account of methods of obtaining and distributing water for the farmer's use. Having a wide practical experience in this field, and possessing an unusually clear manner of exposition, Mr. Bowie is peculiarly fitted to write such a volume. In it the irrigation engineer will find much of value. Furthermore, because of similar requirements, the hydraulic engineer will here discover much necessary information, particularly with regard to reservoirs. The text is supplemented by numerous diagrams and tables, all well indexed. There are 230 pages, 6x9, substantially bound in cloth. The price is $3.00, as published by the McGraw Publishing Company, of New York City.

TRADE CATALOGUES.

Bulletin No. 1111 from the Fort Wayne Electric Works, of Fort Wayne, Ind., is a handsome brochure pictorially showing varied electric motor drives as applied to machine tools. The accompanying text details the merits of the several types of motors manufactured by this company.

No. 3,687, an attractive pamphlet issued by the General Electric Company, Schenectady, N. Y., gives a brief history of the material used in transformer construction, and calls attention to the company's improved Type H transformer in the manufacture of which the described steel is used.

The Thomson direct-current test meter, manufactured by the General Electric Company, Schenectady, N. Y., is described and illustrated in Bulletin No. 4615, just issued. This meter is inclosed in a wooden carrying case, and is furnished in two distinct ampere ratings: 1, 2, 10, 20, 40 ampere, or 5, 10, 50, 100 ampere, each with single 110-volt or double 100/220-volt potential windings. A diagram of connections accompanies the meter and shows the proper method of connecting the meter in the circuit.

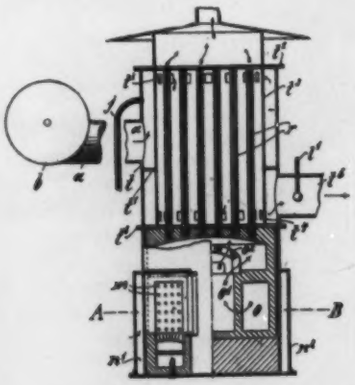
The Electric Railway & Manufacturers' Supply Company, 84-86 Second Street, San Francisco, has issued a valuable catalogue and price list of insulating materials. In addition to a full description, including uses and properties of many kinds of insulating materials, it contains a sample of the material described. Further additions can be made from time to time, as it is handsomely bound in a substantial loose-leaf binder. Full details as to sizes in stock and prices are given. This is probably one of the best aids to intelligent ordering of insulating material yet published.

Bulletin No. 4612, recently issued by the General Electric Company, Schenectady, N. Y., illustrates and describes an automobile instrument consisting of a combination ammeter and voltmeter enclosed in a dust-proof and moisture-proof aluminum case designed to withstand the constant vibration and exposure incident to service on electric vehicles. The two scales of this instrument are so arranged that they may be read simultaneously, and a suitable bracket carrying a miniature lamp with shade, for illuminating the dials, can be furnished if desired.

PATENTS

GAS HEATING STOVE. 897,732. Heinrich Gerdes, Berlin, Germany.

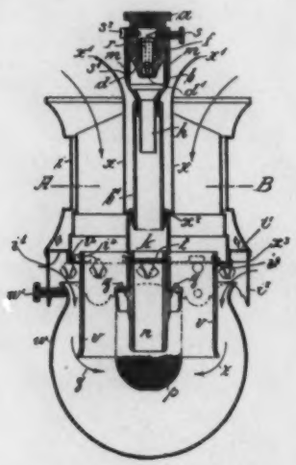
In a gas heating stove, the combination of a hollow fire door, an annular combustion chamber, a series of burner pipes to establish communication between the hollow fire door and the said combustion chamber, a gas feed to the door, and bridges in the combustion chamber of material



adapted to be brought to a glow heat when the gas burners are ignited, a cylinder mounted above the said combustion chamber and having air inlet and outlet, a series of tubes within said cylinder having their lower ends in open communication with the said combustion chamber and their upper ends leading to a chimney, substantially as described.

INVERTED INCANDESCENT GAS LAMP. 897,616. Max Graetz, Berlin, Germany.

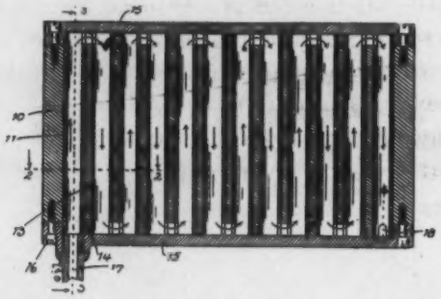
An inverted incandescent lamp having in combination, segmental chimneys, a burner tube disposed in an air space between and supporting said segmental chimneys, a burner



tip, a mantle supported by said burner tip, a transparent extension common to said segmental chimneys and surrounding the mantle, a globe closed at its lower end and supported from said segmental chimneys, an outer casing supported from said chimneys and leaving an air-circulation space between itself and the chimneys.

GAS GENERATOR. 897,792. George F. Silvey, Alexandria, Ind.

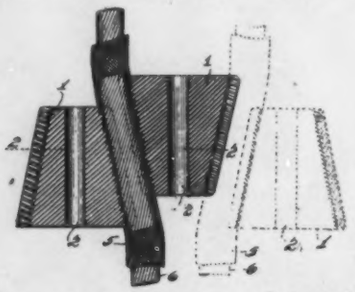
Means for generating gas from crude oil, including a main frame with a series of holes there through, and remov-



able tubes insertible in said holes for forming a conduit and retort, said tubes being formed of longitudinal sections, whereby the tubes may be readily removed and cleaned.

ELECTRIC CABLE LAMP. 897,300. Ernest W. Muller, Brooklyn, N. Y., assignor to Hubert Krantz, Brooklyn, N. Y.

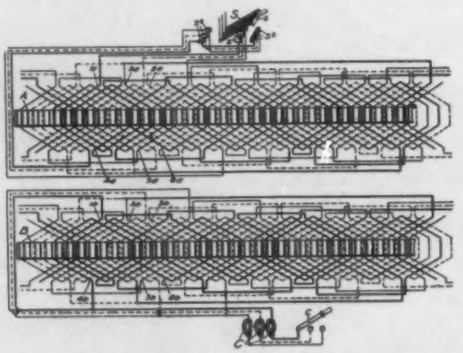
In combination with an electric cable comprised of a conducting core and outside insulating cover, a clamp composed of opposed wedge-like insulators having projections on their



faces adapted to penetrate the cover of the cable and firmly secure themselves in the metal of the conducting core, whereby the strain on said cable at the clamp may be borne by the core directly, a supporting frame for the insulators and mechanical means for initially causing said teeth to bite through the insulating cover and grip the core.

ALTERNATING-CURRENT MOTOR. 897,508. Ernst F. W. Alexanderson, Schenectady, N. Y., assignor to General Electric Company.

In an alternating-current motor, a laminated primary member, two primary windings of different pole numbers carried on the same part of said member, two secondary



windings of corresponding pole numbers, means for connecting one primary winding to a source of alternating-current and short-circuiting the other, connections between the two secondary windings whereby the current induced in one is supplied to the other, and means for short-circuiting each of the secondary windings.

INDUSTRIAL

INVERTED GAS LAMPS.

The inverted type of incandescent gas lamp shown in Fig. 1 marks the latest step in the advancement of gas lighting. In general, the burner and mantle are in substance the same as the familiar upright mantle burners, adapted, however, to burn in the inverted position. The light from such a combination is wholly unobstructed in the lower hemisphere, and 67 per cent of its total light is thrown downward without the necessity of reflectors. The upright burners with reflectors distribute 55 per cent of their total light above the horizontal. The great advantage of this one point can be readily appreciated. If reflectors are used, they are simply supplemental, as two-thirds of the light is thrown down without them, thereby saving the loss necessary where it is required to reflect all the light. The design of the inverted burner is attractive in appearance, lending itself to all kinds of decorative effects, and it is adjustable to almost every conceivable scheme of illumination.

The lighting element, the mantle, is much shorter than the upright mantle, and its downward end is hemispherical. These features produce more perfect combustion at the mantle surface, increasing its temperature and efficiency. The size and character of the mantle and its mounting give it greater strength and longer life than mantles of the upright type.

The quality of light is exceptionally pleasing to the eye. It is a near approach to daylight, and has been pronounced by many color specialists ideal for truly judging delicate shades and matching colors.

The extremely high temperature at which the mantle is operated, its greater efficiency, greater downward light, and small radiating surface are factors which materially reduce the heat units per candlepower over other forms of incandescent gas lights.

By using a small amount of the total light and distributing it above the horizontal for producing color and decorative effects, there is still left a large volume of natural downward light, unaffected for its real work, i. e., illumination. Reflectors and globes of all styles and for all requirements can be had which will produce a soft, diffused, pleasing, and mellow light, or an intense searchlight effect, as the case requires.

This light consumes three feet of gas or less, giving an efficiency of 25 candles per cubic foot. The life of Reflex mantles is not guaranteed, as they may be easily broken by mechanical injury, but from experience in maintaining these lights it is known that 600 hours' burning is a fair average, in which time the candlepower will not drop over 20 per cent. Unlike electric filaments, mantles never burn out. Mechanical breakage usually determines their life, although it is generally economical to renew unbroken mantles after about 800 hours' burning. After this time the decreased efficiency makes it more expensive to operate the old than to buy a new mantle, when it is considered that illumination, and not gas, is the product paid for.

In Fig. 2 a Reflex light is illustrated with a concentrating Holophane reflector, No. 6333. The large volume of light possible to be obtained from a single unit of this kind is plainly shown by the curve—314 candlepower in the vertical direction. In window lighting, by spacing the lights near together, a remarkable volume of white light is thrown on the goods, showing them off in their true qualities and colors. For this class of work this combination is ideal, and, by the aid of the numerous devices recently perfected, it is possible to light the windows by the turn of one key placed at any convenient location.

Fig. 1.

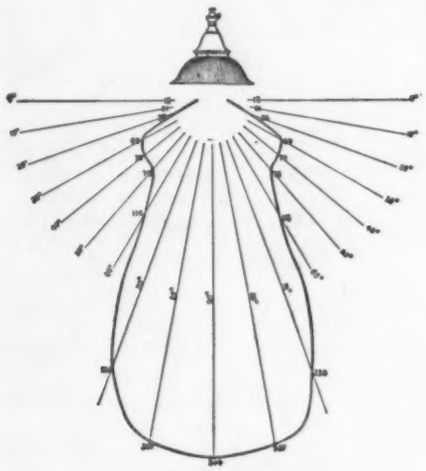


Fig. 2. Concentrating Reflector.

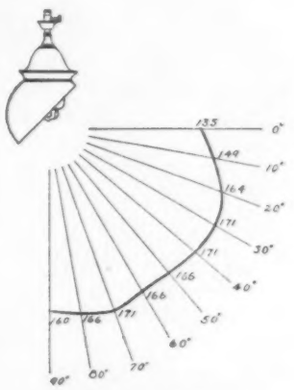


Fig. 3. Angle Reflector.

Reflex Inverted Gas Lamp, Candle Power Curves.

In Fig. 3 is shown a special form of angle reflector, designed to throw most of the light forward and downward, producing an almost uniform candlepower curve of evenly distributed light. It is particularly adapted for certain forms of window lighting, for bowling alleys, show windows, etc., or any place where the eye should be shielded and the light thrown in one general direction.

Fig. 4 shows the Reflex light with No. 503 opal shade. This gives a general distribution of light with the maximum still in the vertical direction. Fig. 5 shows the Reflex light with a No. 442 French roughed globe. While this subdues the light, making it soft and pleasant, the amount cut off by the globe is very small, and the distribution remains exceptionally good for general lighting, the larger percentage always being in the lower hemisphere.

Cost Analysis.

The proper way of rating illuminants is a question not finally settled. It will be noted that in all commercial figures lamps are rated on the maximum candlepower in some given

direction. The standard for *scientific* rating is the mean spherical candlepower, i. e., the total flux of light measured all over the surface of a sphere of given diameter with the light source in its center. This is not regarded as the correct principle for commercial rating, as it does not give an idea of the value of a lamp for practical illumination, and furthermore, such a rating is wrong, generally speaking, because a light source may be of high spherical candlepower, yet when equipped with accessories to direct the light where needed it is much lower in efficiency than a lamp which may give, by virtue of its design and construction, a better distribution. For this reason the value of a light should be determined and compared on the basis of mean lower hemispherical candlepower.

The comparative costs have been worked out on both bases, the spherical and lower

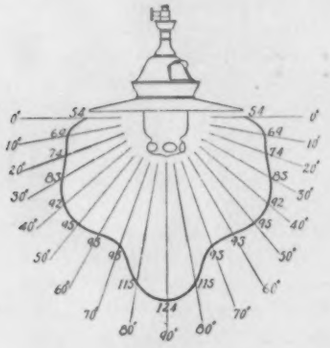


Fig. 4.
Flat Shade.

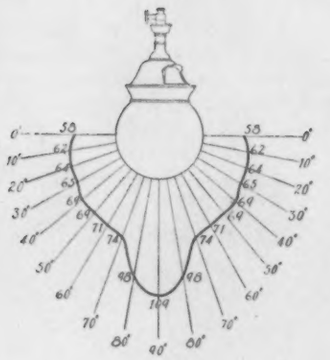


Fig. 5.
Ball Globe.

hemispherical, but have not been compared as to manufacturers' rated candlepower, as these are entirely misleading.

The gas rate at $1.00 and electric rate at 10 cents are believed to be as near an average as could be used for our analysis although they vary in almost every city. The consumption for 1,000 hours is taken as the average time of burning lights for one year—practically three hours daily for 313 days. From these figures and others, taken from standard authorities, results have been obtained showing actual comparative costs of the various lamps. To obtian exact figures with any particular gas and electric rates, simply substitute them in place of the $1.00 and 10-cent rates.

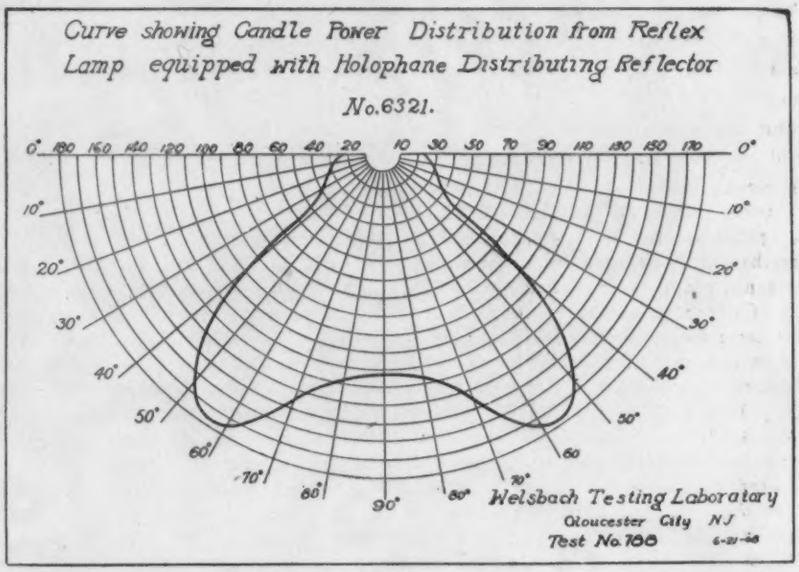
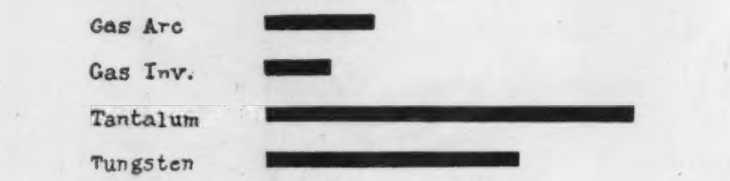
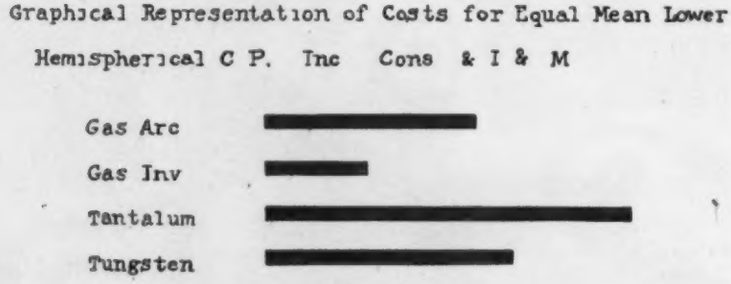
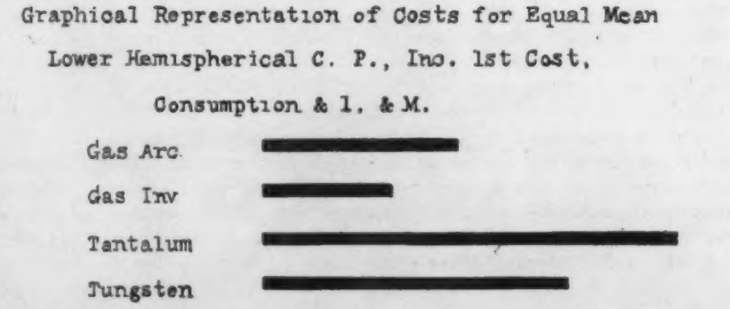

Curve showing Candle Power Distribution from Reflex Lamp equipped with Holophane Distributing Reflector
No. 6321.
Welsbach Testing Laboratary
Gloucester City N.J.
Test No. 788

Fig. 6.

Some companies furnish a system of inspection and maintenance on gas lamps. This includes, besides weekly clearings, free renewals of glassware and mantles. A customer on this service can figure his gas cost and add it to his inspection and maintenance cost and obtain his total cost, there being but the two costs to figure in determining his total lighting bill. The electric companies have a similar service in their lamp renewals. The old carbon-filament lamps were renewed free of


Graphical Representation of Costs for Equal Mean Lower Hemispherical Candle Power Inc. Consumption and Renewals
Gas Arc
Gas Inv.
Tantalum
Tungsten




Graphical Representation of Costs for Equal Mean Lower Hemispherical C. P., Inc. 1st Cost, Consumption & I. & M.
Gas Arc
Gas Inv
Tantalum
Tungsten

charge, but for the two lamps in question a nominal charge is made for renewals. Comparing the cost for consumption and inspection and maintenance (for the gas) and consumption and renewals (for the electric), and reducing to an equal candlepower basis, the best electric (Tungsten) costs about two and one-half times as much as the gas Inverted. A consumer, in buying illumination, can get the same results with the Inverted Gas lamp as with the Tungsten Electric and save over 57 per cent of the cost. This takes into consideration the purchase price of the lamps and their entire upkeep, with weekly cleaning and all free renewals when required.

The cost of wiring for electric and piping for gas is about the same for moderate-sized installations. If the electric installation includes wall switches, the cost for electric is materially higher than for gas.

The point may be raised in the minds of some that the figures on the various lights compared should have been taken with their standard glassware. In answer to this, it was considered that whatever change might result by using any style reflector (changing the distribution of the light) could be produced as well on one or all, but not in reality putting them on the same basis. The peculiar construction of one lamp or its inherent features might require a certain kind of reflector more than another, in which case it would be manifestly unequal to compare them with the reflectors, as the loss by each different reflector would have to be deducted. The comparison of bare lamps is, therefore, considered to be more nearly accurate.

NEW YORK ELECTRICAL SHOW.

An electrical show is to be held at Madison Square Garden, New York City, from October 3 to 14. Prominent features will be displays illustrating the application of electricity to domestic uses and to metallurgical processes.

LARGE STORAGE BATTERY INSTALLATION.

The Electric Storage Battery Company, of Philadelphia, Pennsylvania, has recently closed a contract with the Chicago City Railway Company to furnish and install in the latter company's Plymouth Court sub-station a storage battery, complete with booster, switchboard, and wiring, rated at 4,800 amperes for 1 hour, it being permissible to discharge the battery at rates up to 9,600 amperes in emergency service. The battery is to be operated on a 550-volt bus. It will be charged at times of light load and discharged as occasion may require on the peak loads. Its location will be adjacent to the Loop District of Chicago, which will make the battery of value as a reserve in the event of any derangement of the sub-station, high-tension transmission lines, or power station.

CROCKER-WHEELER POSTOFFICE.

In order to facilitate handling the increasing volume of mail at the Ampere, N. J., postoffice, the Crocker-Wheeler Company, manufacturers of electrical machinery, have built a brick and cement postoffice building on their grounds. The architecture is of a modern classical style, which might be termed "federal." Upon the pediment above the main entrance is an eagle and United States shield in high relief. The interior of the building is finished in quartered oak and the floor is of mosaic tile. Upon the walls hang a facsimile of the Declaration of Independence, with the coats of arms of the various States, a Constitution of the United States, and an autograph letter and portrait of A. M. Ampere (1775-1836), after whom Ampere is named and whose name is also used throughout the world to designate the unit of electric current. The new postoffice will still further beautify the grounds of the Crocker-Wheeler Company.

HOLOPHANE-D'OLIER METAL REFLECTORS.

The Holophane Company has acquired and hereafter will have exclusive control of the metal reflectors designed by and manufactured under the patents of Mr. Henry D'Olier, Jr.

It is the policy of the Holophane Company to maintain absolute leadership in the field of illumination. This policy has been expressed in constant improvement of Holophane globes and reflectors, in the adding of new designs to meet new conditions, in the development of the scientific fixture for tungsten lamps, and in the maintenance of an engineering department which acknowledges no superior.

The addition of this line of metal reflectors is a further step in advance. Metal reflectors have a distinct place. In industrial plant lighting, in certain classes of display-window illumination, and in many cases where excess of dust and grime, or liability to breakage, is constant, the use of glassware is almost always inadvisable and frequently absurd. On the other hand, the use of ordinary metal "shades" cannot be recommended because their only practical advantage is that of protecting the eye from the glare of the bare lamp.

With Holophane-D'Olier metal reflectors, however, we have a line which combines scientific design, high efficiency, and extreme flexibility—a line which the illuminating engineer can employ to secure exact results—a line which can be used by any one, anywhere, to advantage and with economy.

Holophane-D'Olier metal reflectors are made in 28 sizes and styles and are furnished in four exterior finishes: brush brass, polished brass, oxidized copper, and green enamel. The interior finish in all cases is a special "satin aluminum" produced by secret process, and giving a soft, well-diffused reflection of almost pure white color.

These reflectors require no shade holders, as each is provided with an attached clip spring holder, reinforced with a heavy steel ring. This can be snapped on to any lamp socket in an instant, and, while holding the reflector firmly, allows it to be easily rotated about the lamp, thus throwing the light in any desired direction.

Holophane-D'Olier metal reflectors are wrapped in waxed paper and packed individually in stout cartons, plainly labeled. This is a departure which we believe the trade will appreciate. While these reflectors are practically indestructible when in service, they are not proof against rough handling and carelessness upon the part of clerks and stock boys. This is but one of the many innovations made by the Holophane Company when assuming control of the D'Olier reflectors.

The Holophane-D'Olier line will be sold upon the same conditions as Holophane globes and reflectors. Exact photometric data will be published to substantiate every claim for efficiency. The Holophane standard of quality will be rigidly maintained. Wherever our engineering or sales departments can be of assistance to our trade, they will gladly lend their services.

We believe that Holophane-D'Olier metal reflectors are destined to wide use and great popularity, and we earnestly urge our customers and the trade to investigate their merits and possibilities.

MAGNALIUM.

An alloy of aluminum and magnesium called magnalium is said to have greater strength than aluminum, in spite of being lighter, its specific gravity being about 2.5, while that of pure aluminum is 2.64. It can be forged like Swedish steel and worked like brass, giving a smooth surface of silvery color. It attains and maintains a high polish, and is unaffected by atmospheric agents. Magnalium can be soldered; its electric conductivity is 56 per cent, that of pure copper; the melting point is 1,185 to 1,250 degrees F.; its specific heat is 0.2185.

THE STEAM TURBINE.

(*Continued from page 185.*)

The Chairman: I believe we have with us Mr. Hilleary, of Los Angeles, who has had considerable experience with turbines.

Mr. Hilleary: I know very little about this. We had occasion to build some of these step bearings, about which some remarks have been made this evening. The step bearing is, I think, a very much abused piece of cast iron—that is all it is. I cannot say that we have had trouble through our step bearing which was not due to the design of the machine. The step bearings that we built were just as the General Electric Company built them, and after they had run a while they began to shake. We found that the trouble was in not turning the recess in both parts the same. That is the only case where we had to take a step bearing out because the machine vibrated; that is the only thing a step bearing can do. We ran our bearings about a year or such a matter before we took them out for inspection. The trouble that we have had with these step bearings outside of that has been, I suppose, not more than twice, and that has been due to the triplex-driven step bearing that we put in when the machine was first installed. With our water supply we use no strainer. We take it from a well, where it gets all kinds of impurities in it in the shape of scale, which gets into the pipe. It goes into the step bearings, and we put it right on through without any trouble. The first trouble we had on that ground was on account of the scale getting into the triplex pump and letting the pressure drop; we could not maintain the pressure at that time. I believe our turbines have had about as rough usage as any company could have put a turbine to to demonstrate these defects or whatever you may call them; but no people seem to have all the troubles centered in the step bearings, and I believe if they are properly handled they will find them the least. As far as the Westinghouse machine is concerned, we have never had any trouble with that. We have had a few accidents, but we have traced them down and found just exactly what caused them, and they were not due to the design of the machine; in fact, the same thing would not be apt to happen with the machine. We had made tests with our machine, and we find that the result has been below the guarantee. I think the guarantee is on too close lines. Any one buying a turbine would be safe in depending on getting a machine that would give the economy that is claimed for it. I believe this is all I have to say about the turbine.

The Chairman: I would ask you what you use on the step bearings—what lubricants you use.

Mr. Hilleary: We have always used water. We take it out of our hot well and put it through the turbine and through the condenser and out of the hot well again; but on the middle and upper guide bearings we use oil.

Mr. Bowie: I would like to ask if there has any test been made of the Curtis turbine in regard to taking the weight of unbalanced pressure.

Mr. Vickers: The step bearing takes care of it all.

The Chairman: I believe Mr. Ransom is here. We would like to hear something from him on the subject.

Mr. Ransom: I am contemplating the installation of a turbine, but I am here looking for information, to see what could be said in favor of turbines.

The Chairman: Has any one else anything to say on this subject? Can you give us anything about the turbine, Mr. Doble?

Mr. W. A. Doble: I built a turbine away back in the nineties, but that is too long ago, and I could not say anything about it.

The Chairman: We have heard about the turbine end, and we would like to hear something about the turbine-driven generator. I will call upon Mr. Lamme.

Mr. W. F. Lamme: Mr. Chairman, the turbine generator is very much like an ordinary generator. The only difference between a turbine generator and any other is one of mechanical strength. The stationary part of the turbine generator is very much like that of the ordinary generator, but the rotating part has to be very carefully made. Usually they use steel and are very careful about the steel being such as will stand the strain. With the type of generator that I am acquainted with, the steel windings are buried in slots cut in a cylinder. The slots are wedged in place with brass wedges. We tried many other constructions, but this is the construction that we finally settled upon. The reason for this was to gain the necessary mechanical strength, and by this means hold the bobbins in place and prevent breaking of the castings. That is all I have to say on that.

The Chairman: Anybody else anything to say on this subject? We would be glad to have any questions.

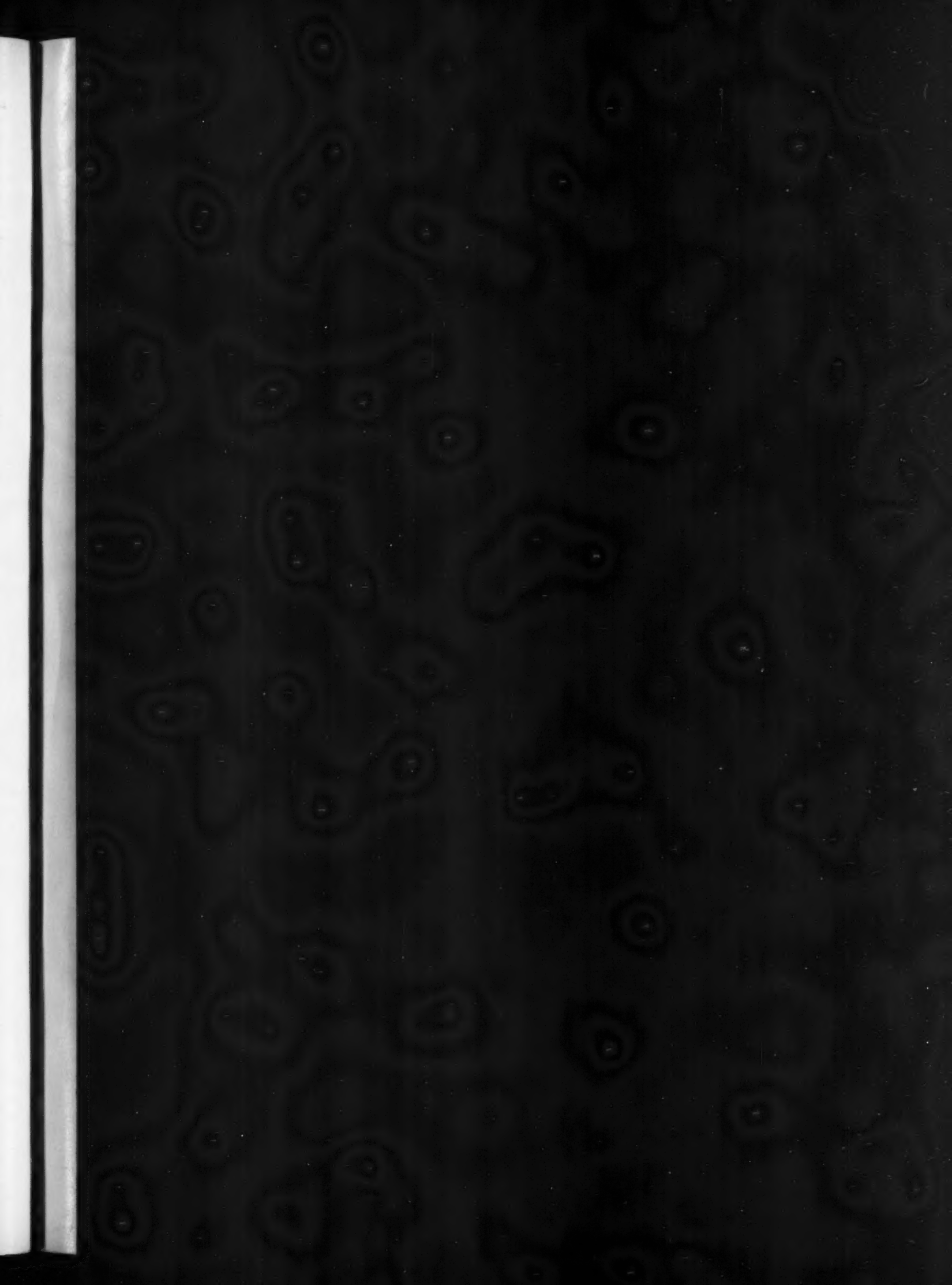
Mr. B. C. Shipman: Regarding the question of expansion of steam from a certain pressure, that Mr. Dunn spoke of, to atmosphere, it seems to me that is just the same as expanding from 150 pounds to 125 pounds, as from 150 to atmosphere, if the velocity were constant; in other words, if you were going to expand from 150 pounds down to atmosphere, the velocity would be the same.

Mr. Dunn: That depends entirely upon whether you are expanding against a fixed back pressure. If you are expanding —I do not remember the exact figures, but, say, from 180 pounds to the atmosphere, you have a velocity of approximately 3,000 feet. If you are expanding down to a vacuum of 28 inches, you have a velocity of about 4,000 feet; and from atmosphere to 28 inches vacuum you would have a velocity of about 3,000 feet.

Mr. Jorgenson: There is no end thrust, or very little, on a Curtis turbine, for the reason that the bucket entrance angle is equal to the outlet angle on all runners. As the absolute outlet velocity is slightly less than the relative entrance velocity through all runners, due to steam friction loss, this small difference causes some thrust. In a Parsons turbine the bucket inlet angle is about 90 degrees, and the outlet angle about three times smaller, causing a thrust in the direction of the shaft.

Mr. Vickers: In some of the Curtis turbines there is a slight difference between the entrance and exit angles, which would cause some thrust; but it is very slight.

A Member: I would like to ask Mr. Vickers, in a case of a small non-condensing turbine, how the economy at the quarter load would compare with the full load economy.

Mr. Vickers: Between half load and full load there is probably 10 per cent difference. I cannot give you anything on quarter loads.

Mr. Dunn: The proposition of the steam turbine, non-condensing, it is not as economical as a compound reciprocating engine would be. If you take a compound engine, which is operating non-condensing, and put a condenser on it, you gain about 20 per cent. If you put a condenser on a turbine, you gain about 100 per cent.